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# DRAFT

## Information Technology Laboratory (ITL)

## Demonstration Description
## for the
## JLENS OmniEye Demonstration

**June 2000**

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US Army Space and Missile Defense Command

Advanced Technology Directorate

## EXECUTIVE SUMMARY

This document contains the demonstration description for the JLENS OmniEye demonstration conducted as part of SMDC Media Day on 1-2 May 2000. The purpose of the demonstration is to determine the feasibility of using the OmniEye camera technology on the JLENS program for on-board aircraft surveillance as well as ground monitoring. This will be accomplished by flying a commercially available OmniEye camera on the 15 meter Aerostat during the SMDC Media Day activities. The demonstration is described by providing an introduction, technical objective and approach, demonstration configuration, and a summary including demonstration results, lessons learned, and conclusions.

***Keywords:*** *OmniEye, omnidirectional imaging, JLENS, instrumentation, surveillance*

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## APPENDICES

# 1.0 INTRODUCTION

The following section describes the purpose, scope, background, participants and related documents for the JLENS OmniEye demonstration.

## 1.1 PURPOSE

The purpose of this document is to describe the details of the Information Technology Laboratory (ITL) JLENS OmniEye demonstration. The specific technology being assessed in this demonstrated is a omnidirectional camera developed by Genex Technologies, Inc. (GTI) of Kensington, MD under a BMDO-sponsored Small Business Innovation Research (SBIR) Phase 1 and 2 effort managed by the US Army Space and Missile Defense Command (USASMDC).

## 1.2 SCOPE

The demonstration described herein this document only applies to the omnidirectional camera technology and only for the configuration sited elsewhere in this document. The demonstration results described in this document are only valid given the technical approach taken in assessing this technology within the ITL.

## 1.3 BACKGROUND

The US Army Space and Missile Defense Command (USASMDC) Space and Missile Defense Technical Center (SMDTC) Advanced Technology Directorate (ATD) Computer Technologies Division (CTD) serves as an executing agent for the Ballistic Missile Defense Organization (BMDO) Small Business Innovation Research (SBIR) program. It was through this program that a Phase 1 "proof-of-concept" contract was awarded in April of 1997 to Genex Technologies, Inc. (GTI) for "Omnidirectional 3D Camera". This effort resulted in the successful proof of concept prototype demonstration of a camera capable of collecting x, y, and z data in a 360 degree hemispherical field of view.

Following this successful Phase 1 effort, GTI was awarded a Phase 2 contract in May of 1998. The effort called for enhancements of the 2D imaging sensor head, projection light system, and omnidirectional imaging software. The effort also began the development of a series of prototype cameras (including a 2D and 3D version). GTI has successfully developed a commercially available 2D omnidirectional camera under this effort. The camera is known as the OmniEye and is the subject of this demonstration.

The applications for omnidirectional camera technology are numerous. Military applications include surveillance (ground, air), remote instrumentation, and battlefield modeling. Commercial applications include security surveillance, manufacturing, and product inspection.

The use of this technology for on-board instrumentation and remote surveillance on the 15 meter Aerostat (JLENS) is the focus of this demonstration.

## 1.4 PARTICIPANTS

Technology Developer:

- Genex Technologies, Inc., Dr. Jason Geng (PI)

Technology Broker:

- SMDC SMDTC ATD, Gary Mayes (COTR)

Technology Consumer:

- JLENS Project Office, Dan Schneider

## 2.0 TECHNICAL OBJECTIVES AND APPROACH

The following section describes the technical objectives and approach for the JLENS OmniEye demonstration

### 2.1 TECHNICAL OBJECTIVES

The are two main technical objectives for this demonstration. The first objective is to determine the effectiveness of using a omnidirectional camera as on-board instrumentation for the JLENS 15 meter Aerostat system. The second objective is to determine the effectiveness of the omnidirectional camera technology as a ground surveillance system for the same system. Both of these objectives will be accomplished through the flight of the OmniEye camera on the 15 meter Aerostat system.

### 2.2 TECHNICAL APPROACH

The JLENS OmniEye demonstration will be conducted in three parts: Bench Test, Ground Test, and Flight Demonstration. The following paragraphs identify the purpose, scenario, and measures applicable to each test.

#### 2.2.1 Bench Test

**Purpose**. The purpose of this test is to verify the operational status and functionality of the demonstration system.

**Scenario**. This test will be conducted in the SMDC ITL facility and involves the integration of the OmniEye camera, interface cables, video transmitters, fiber optic cable, and the Control Computer. The detailed configuration is described in paragraph 3.1.

**Measures**. The presence of a transmitted image from the camera to the control computer is noted. The images from the test are recorded using the OmniEye software and stored in a file on the computer's hard drive.

#### 2.2.2 Ground Test

**Purpose**. The purpose of this test is to verify the operational status, functionality, and physical integration of the demonstration system in the pre-flight demonstration configuration.

**Scenario**. This test will be conducted in the Advanced Research Center (ARC) parking lot and adjacent field. This test consists of integrating the OmniEye camera, video transmitters, and Coontrol Computer in the operational JLENS 15 meter Aerostat system to determine if an image received by the OmniEye can be transmitted within the demonstration article. The Aerostat will be grounded in a stowed position for this test. This test will also verify the mounting configuration of the OmniEye on the Aerostat 15 meter platform. The configuration for this test is described in paragraph 3.2.

**Measures**. The presence of a transmitted image from the camera to the control computer is noted. The images from the test are recorded using the OmniEye software and stored in a file on the computer's hard drive.

### 2.2.3 Flight Demonstration

The Flight Demonstration consists of sending the OmniEye camera airborne in the Media Day demonstration article. This will be the same configuration as the Ground Test but with the Aeostat airborne. The configuration for this demonstration is described in paragraph 3.3.

**Purpose**. The purpose of this test is to verify the operational status, functionality, and physical integration of the demonstration system during a flight of the 15 meter Aerostat system.

**Scenario**. This test will be conducted in the Advanced Research Center (ARC) parking lot and adjacent field. This test consists of integrating the OmniEye camera, video transmitters, and Coontrol Computer in the operational JLENS 15 meter Aerostat system to determine if an image received by the OmniEye can be transmitted while the Aerostat is in flight at approximately 700 feet. The configuration for the demonstration is shown in Figure 4.

**Measures**. The presence of a transmitted image from the camera to the control computer is noted. The images from the test are recorded using the OmniEye software and stored in a file on the computer's hard drive.

### 2.2.4 Work Plan and Schedule

The following figure identifies the main tasks and supporting schedule required to conduct the JLENS OmniEye demonstration.

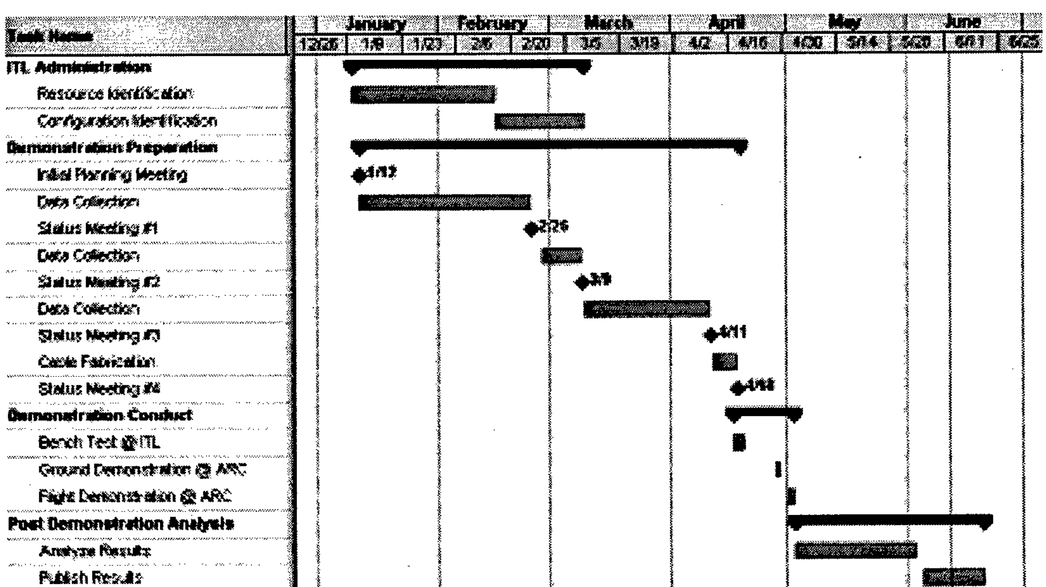


**FIGURE 1 DEMONSTRATION WORK PLAN AND SCHEDULE**

## 3.0 DEMONSTRATION CONFIGURATION

The following section describes the demonstration configuration for the JLENS OmniEye demonstration.

### 3.1 BENCH TEST

Figure 2 illustrates a diagram of the bench test configuration and Figure 3 shows the resulting system that was tested as part of this demonstration. Table 2 identifies the resources required for this test.

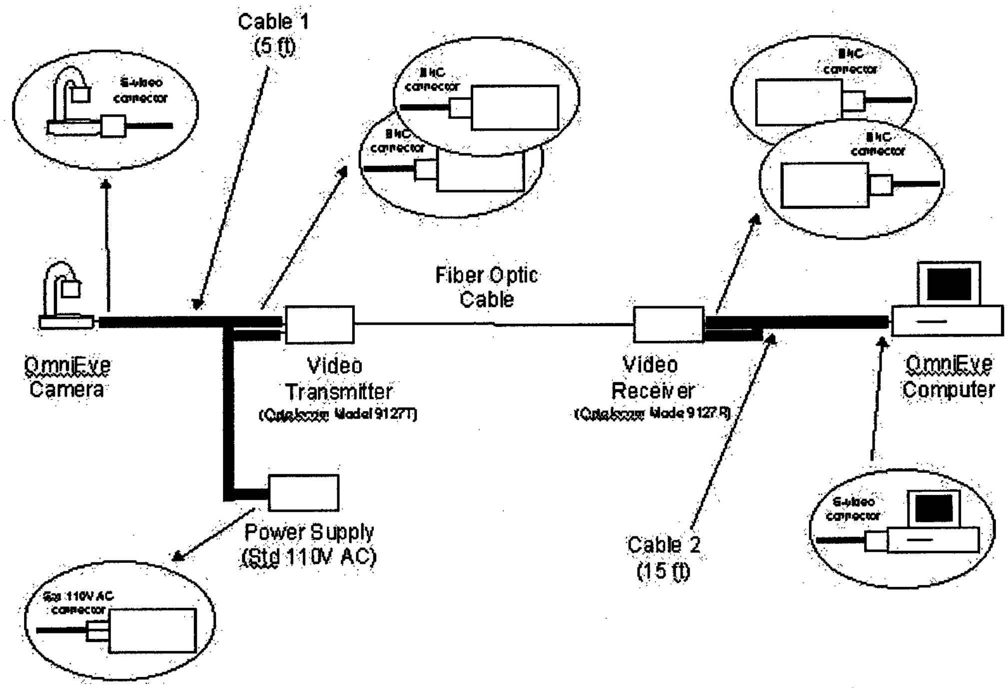


**FIGURE 2 BENCH TEST CONFIGURATION**

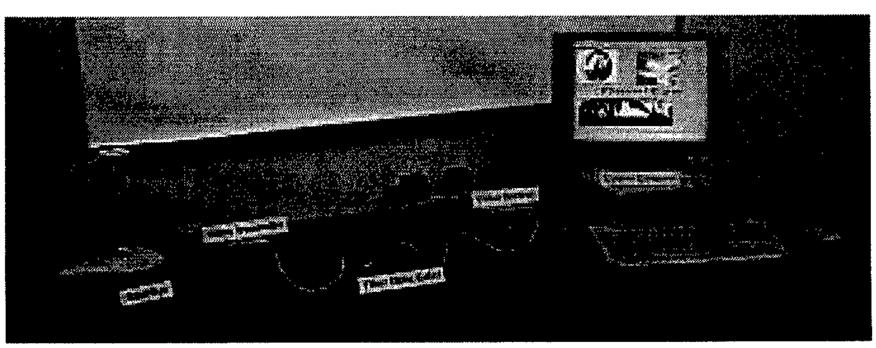

**FIGURE 3 BENCH TEST SYSTEM**

**TABLE 1 BENCH TEST RESOURCES**

| Item | Version | Description |
|---|---|---|
| OmniEye Camera | Version 2 | Developed by GTI, Inc. under BMDO SBIR Phase 2 Program |
| OmniEye Control Computer | N/A | Sony 700Mhz Pentium with 128MB RAM and 17GB hard drive |
| Fiber Optic Cable | N/A | 2ft. length standard fiber cable provided by Unmanned Ground Vechicle (UGV) Joint Program Office (JPO) |
| Cable 1 | Custom | Cable developed specifically for this demonstration by GTI, Inc. S-video type connection on one end and 2 BNC type connections on other end with standard 110v AC power supply. Approximately 15 ft. in length. |
| Cable 2 | Custom | Cable developed specifically for this demonstration by GTI, Inc. S-video type connection on one end and 2 BNC connections on other end. Approximately 15 ft. in length. |
| Video Transmitter | Custom | Provided by UGV JPO. Produced for the Government by Optelecom, Inc. Power supply custom built by SMDC and JLENS PO. |
| Video Receiver | Custom | Provided by UGV JPO. Produced for the Government by Optelecom, Inc. Power supply custom built by SMDC and JLENS PO. |

## 3.2 GROUND TEST

Figure 4 illustrates a diagram of the bench test configuration and Figure 5 shows the resulting system that was tested as part of this demonstration. Table 3 identifies the resources required for this test.

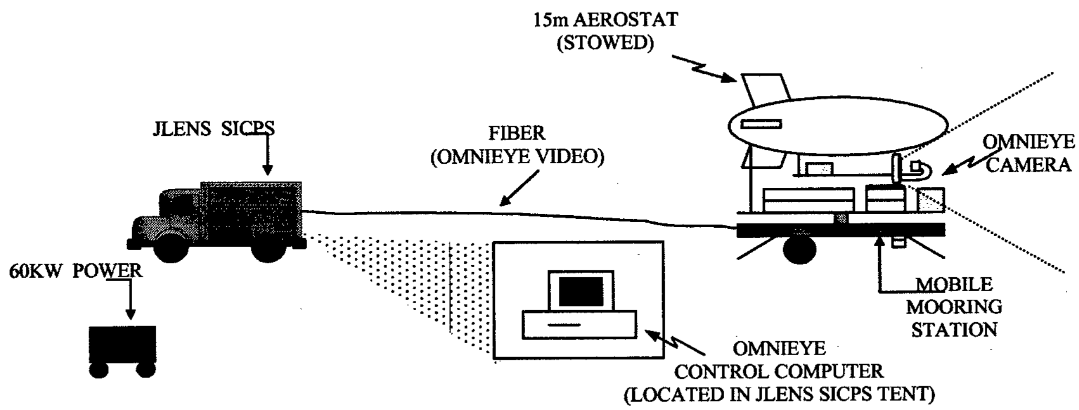


**FIGURE 4 GROUND TEST CONFIGURATION**

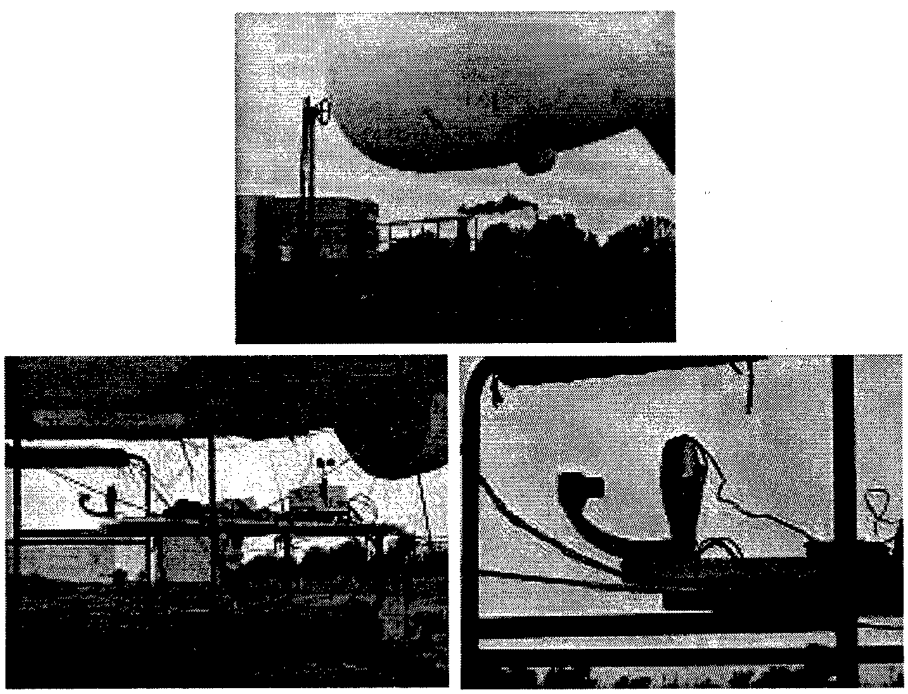

**FIGURE 5 GROUND TEST SYSTEM**

**TABLE 2 GROUND TEST AND FLIGHT DEMONSTRATION RESOURCES**

Resources identified in Table 1 plus the following:

| Item | Version | Description |
|---|---|---|
| Aerostat System | 15 meter | Includes balloon, Mobile Mooring Station (MMS), and JLENS SICPS |

## 3.3 FLIGHT DEMONSTRATION

Figure 5 illustrates a diagram of the bench test configuration and Figure 6 shows the resulting system that was tested as part of this demonstration. Table 2 identifies the resources required for this test.

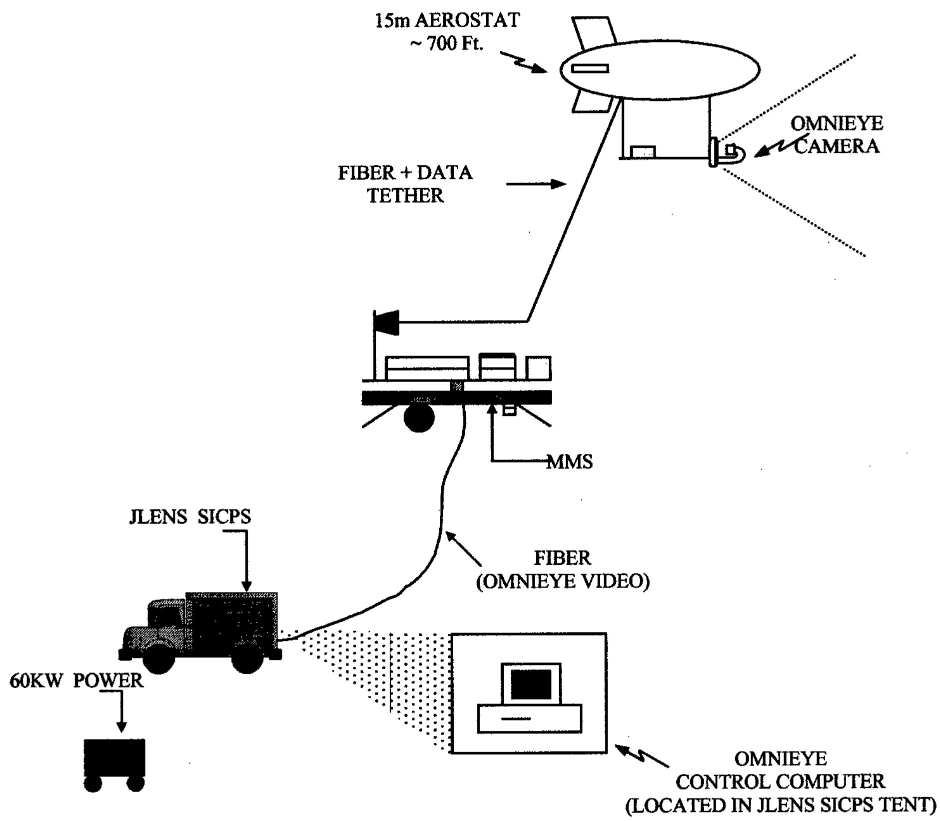


**FIGURE 6 FLIGHT DEMONSTRATION CONFIGURATION**

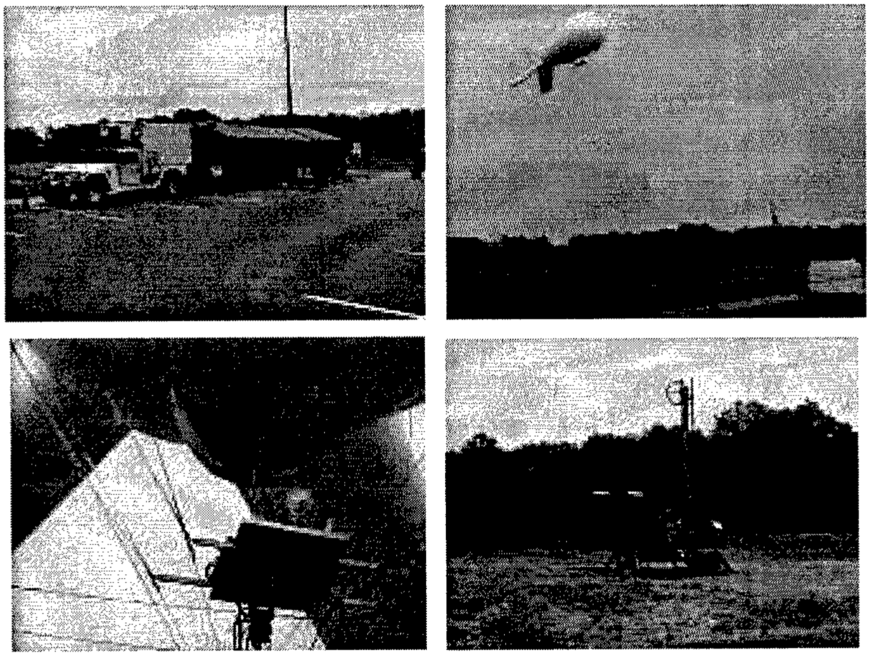

FIGURE 7 FLIGHT DEMONSTRATION SYSTEM

## 3.4 FACILITIES

### 3.4.1 SMDC ITL

The ITL is a technology transition mechanism for the identification, assessment, demonstration, and maturation of emerging and enabling information technologies. The SMDC node of ITL located in 2B1603, was used to conduct the "Bench Test". Figure 8 shows the ITL SMDC facility.

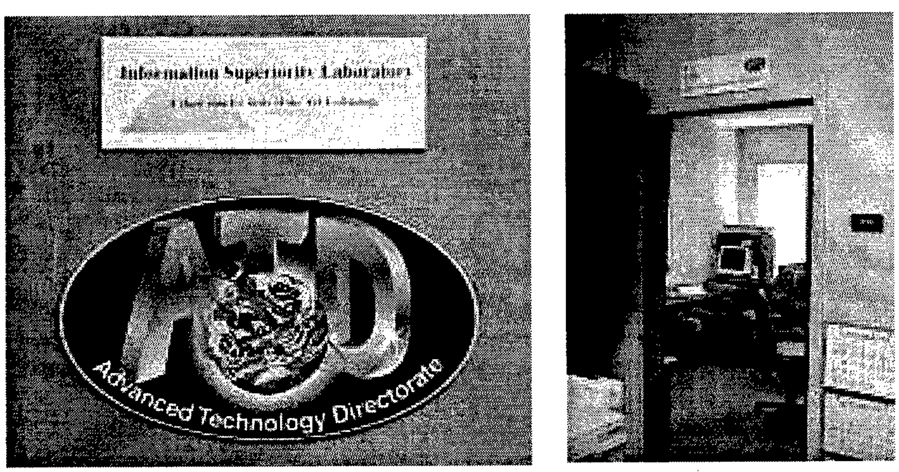


FIGURE 8 INFORMATION TECHNOLOGY LABORATORY SMDC NODE

### 3.4.2 Advanced Research Center (ARC)

The ARC facility provides a flexible and cost-effective research and development computational testbed for the National and Theater Missile Defense programs. The 2000 SMDC Media Day was held at the ARC on 1-2 May 00. The "Ground Test" and "Flight Demonstration" was conducted at the ARC in the parking lot and adjacent field. Figure 9 shows the ARC Facility and area used for this demonstration.

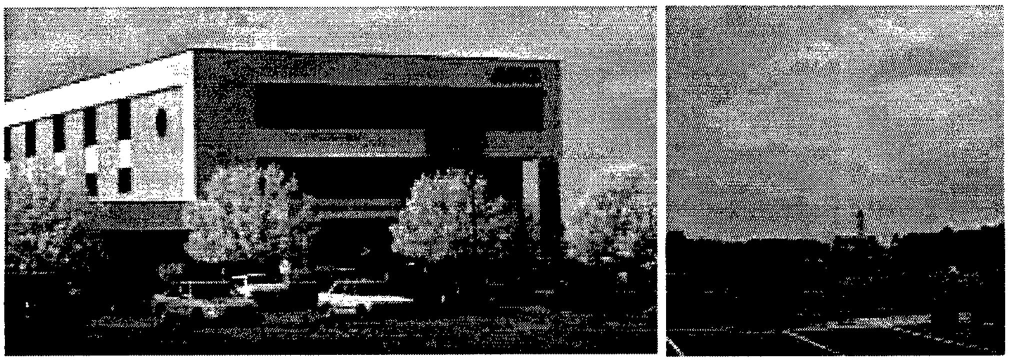

**FIGURE 9 ARC FACILITY**

# 4.0 SUMMARY

The following section describes the results, lessons learned, and conclusions for the JLENS OmniEye demonstration.

## 4.1 RESULTS OF DEMONSTRATION

This section identifies the results of the bench and ground tests and the results from the demonstration flight.

### 4.1.1 Bench Test

The Bench Test was conducted on 17-19 April 2000 in the SMDC node of the ITL. Several screens shots were captured that highlight the successful operation of the test. Figure 10 provides some images that were captured from the OmniEye camera as it was transferred over the fiber optic cable and through the transmitter/receiver boxes. This test verified that the cables and interfaces required for the system demonstration were operationally sound and in working order.

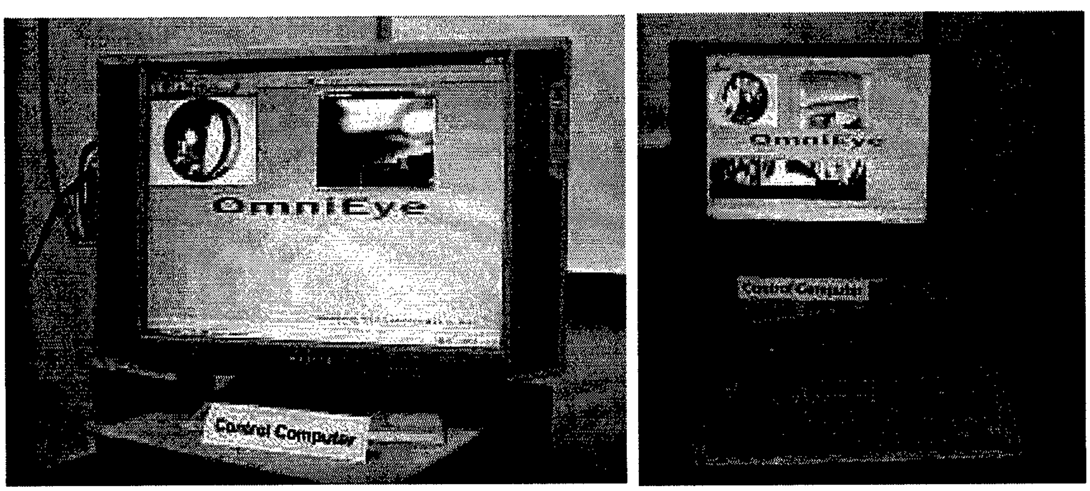


**FIGURE 10 BENCH TEST IMAGES**

### 4.1.2 Ground Test

The Ground Test was conducted on 29-30 April 2000 at the ARC parking lot and adjacent filed. This was the site of the JLENS Media Day demonstration. A one and a half (1.5) minute video clip was captured while the OmniEye was mounted on board the Mobile Mooring Station in the stowed position. The video clip file was named "ground_test.gim" and is approximately 309MB in size. Figure 11 show images from the Ground Test. This test verified that the demonstration configuration was operationally sound and in working order.

**FIGURE 11 GROUND TEST IMAGES**

### 4.1.3 Flight Demonstration

The Flight Demonstration was conducted on 1-2 May 2000 at the ARC parking lot and adjacent filed. This was the site of the JLENS Media Day demonstration. A seven (7) minute and a three and a half (3.5) minute video clips were captured while the OmniEye was mounted on board the test payload rack and in flight at approximately 700 feet. The video clip files were named "flight_demo1.gim" and "flight_demo2.gim" and are approximately 1.41 GB and 693MB in size, respectively. A "band" appeared in the image on the second day of the demonstration. The power supply that was on-board the payload camera had a problem with it causing the "band" to appear on the image. Figure 12 show images from the Flight Demonstration Test. This test verified that the OmniEye camera can successfully obtain a video rate of 30 frames per second (fps) and transmit the video via fiber optic cable to a control computer that stores the video digitally on the computer's hard drive.

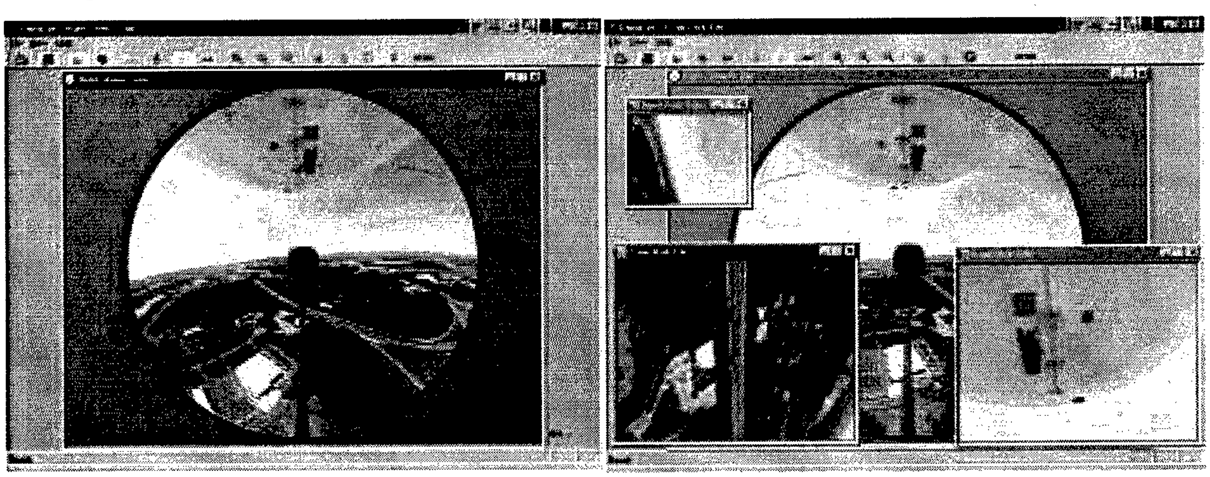

**FIGURE 12 FLIGHT DEMONSTRATION IMAGES (640X480)**

**FIGURE 13 FLIGHT DEMONSTRATION IMAGES (320X240)**

## 4.2 LESSONS LEARNED

This section identifies the lessons learned from the planning, development, and conduct of the JLENS OmniEye Demonstration. The lessons learned (LL) are grouped into categories, with a statement of the lesson learned indicated in bold type as well as supporting rationale.

### 4.2.1 Demonstration Planning and Technology Transition

**LL1: Demonstrations require Adequate Resources**

A significant amount of resources was expended during the planning, development, and conduct of this experiment. Approximately [xx] manhours of Government personnel and approximately [xx] manhours of contractor personnel were required to successfully complete this effort. In addition to the manhours spent, the contractor spent an additional $ [xx] on hardware improvements. There were several areas within the demonstration that could have been significantly improved if additional resources would have been provided. These areas include the mounting of a second OmniEye camera on-board the payload, image processing software modification, data compression inclusion, and contractor participation in the demonstration. While the demonstration was successful, a nominal amount of additional resources could have improved the demonstration considerably. One specific example was the payload power supply issue. A higher quality power supply would have lasted longer that the one obtained for this demonstration.

**LL2: Technology Awareness is Key to Initiating Technology Transition**

It is critical to have mechanisms to facilitate the awareness of new developments in the technology world. This can take the form of briefings, demonstrations, and other methods to communicate new and emerging technology that might be applicable to systems needs. The potential application of the OmniEye technology to the JLENS program is a result of a technology demonstration day conducted o 22 Oct 99 by the Space and Missile Defense

Technical Center (SMDTC) Advanced Technology Directorate (ATD). It was at this demonstration day that a member of the SMDC's Battle Lab viewed the technology demonstrations and indicated to the demonstration coordinator that the JLENS program was looking for technology that would "enhance system availability". The demonstration coordinator took this information and used it to start a dialogue with the JLENS Program Office that eventually led to this demonstration of the OmniEye camera with the 15 meter Aerostat system.

### 4.2.2 Demonstration Conduct

**LL3: Carefully Plan Data Acquisition and Transfer Effort**

The OmniEye camera has three setting in which it can capture images. These are 30 frames per second (fps), 10 fps, and 5 fps. For the demonstration, the camera was set to collect images at a rate of 30 fps. There were three video clips captured and stored on the control computer's hard drive during the demonstration. The combined file size of the three files was approximately 2.5 GB with the largest file at just under 1.5GB. This presented a problem when attempting to transfer the files from the contractor's control computer to another computer for analysis. Several hours were expended transferring this data using the WinZip file compression utility and a Iomega 250 MB Zip disk drive. A well planned and thought out process for transmitting the data to another format would have prevented this issue. Ensure that the entire process of data acquisition and transition is realistically emulated during the planning and test phases of the demonstration.

**LL4: OmniEye Mounting Configuration and Image Orientation**

Originally the OmniEye was to be mounted looking up at the Aerostat. JLENS personnel indicated their desire to look both up and down. Next, the possibility of mounting two OmniEye cameras, one looking up at the Aerostat and one looking down at the ground, was explored. It was determined that this was not feasible because of the lack of availability of two identical OmniEye camera configured to fly on-board the Aerostat. Finally, it was decided to mount the OmniEye camera looking forward. This allowed the camera to look up and down in the OmniEye view. This decision was made after the completion of the Bench Test . It was noted during the Flight Demonstration that the OmniEye view image was a reverse mirror image of the actual scene being viewed. It was also noted that the OmniEye image viewer software was oriented for the camera to be mounted in the up or down position but not in the forward position as done in this demonstration. While a complete image can be viewed adequately, the image is rotated by ninety degrees. The OmniEye image viewer does not presentaly provide the capability to rotate images.

### 4.3 CONCLUSIONS

This section identifies the conclusions from the planning, development, and conduct of the JLENS OmniEye Demonstration. The conclusions (CONC) are grouped into categories, with a statement of the conclusion indicated in bold type as well as supporting rationale.

### 4.3.1 Application to JLENS Program

**CONC1: On-Board Instrumentation**

One area of potential application of the OmniEye technology to the JLENS program is to improve the system's availability for missions. JLENS program literature indicates that there are plans to enhance system availability through addition of cameras as on-board instrumentation. As a result of this demonstration, the OmniEye successfully demonstrated the capability to capture images surrounding the Aerostat vehicle. With the camera weighing less than five (5) pounds and utilizing the existing communications infrastructure to transmit the video data, the OmniEye should be considered a candidate technology to meet this system improvement requirement of enhanced system availability.

**CONC2: Low Altitude Surveillance**

Another area of potential application of the OmniEye technology to the JLENS program is to provide a lightweight surveillance systems for the 15 meter Aerostat system. This could be used for remote critical asset site monitoring and border control. As a result of this demonstration, the OmniEye successfully demonstrated the capability to capture images from the ground at approximately 700 feet in the air. The video was able to capture movement of vehicles on the ground at that distance as well. With improved resolution to the camera, the OmniEye should be considered a candidate technology to meet this future requirement of low altitude surveillance.

### 4.3.2 Technology

The following conclusions were reached by the conduct of this demonstration and result in the identification of new or improved OmniEye camera cabilities. Additional capabilities mentioned as a result of this demonstration included the incorporation of an infrared camera with the OmniEye and a wireless communications channel.

**CONC3: Image Resolution**

It was clear as a result of this demonstration that for the JLENS application, as well as additional applications requiring a "Zoom" feature, that the OmniEye camera would benefit from increased resolution.

**CONC4: Software Orientation**

The demonstration showed that OmniEye image viewer needs the capability to manipulate images freely, in particular, the feature that would allow the images to be rotated. This would allow the OmniEye camera to be mounted in a number of configurations and allow the images to be viewed in the proper perspective.

## 5.0 REFERENCES

"Information Superiority Laboratory (ISL) Architecture Description", US Army Space and Missile Defense Command, ISL-AD-SEP-99-001, September 1999.

"JLENS Program Overview brochure and CD-ROM", [need to add date here].

# APPENDIX A

## MEDIA DAY IMAGES